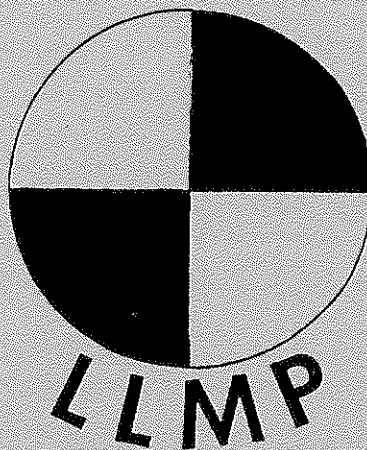


CHOCORUA LAKE
LAKE LAY MONITORING PROGRAM
1984

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ACKNOWLEDGMENTS

Chocorua Lake has been a participant in the Lake Lay Monitoring Program for four years. Through the direction of Dr. Arthur Baldwin, the program has continued strongly in 1984. One site was monitored on Lake Chocorua, site 1 "South Pool." The lay monitors on the lake were Dr. Baldwin and Alan Smith.

We congratulate the lay monitors on the quality of their work and anticipate that the monitors will continue their efforts next year. We also express our appreciation to Dr. Baldwin and all the other members of the Chocorua Lake Association for their time and effort.

The Office of Computer Services kindly provided computer time and data storage space for the Lake Lay Monitoring Program. The final text was set with Wordstar on Northstar and Zenith microcomputers, and printed on a letter-quality Spinwriter.

SUMMARY OF LAY MONITOR DATA

1) Chocorua Lake is meso-oligotrophic based on moderate Secchi disk depth (range 3.5-5.5 meters), and oligotrophic based on low average chlorophyll a concentration (1.1 milligrams per cubic meter).

2) Total phosphorus values ranged from 2.5-17.2 micrograms per liter at site 1 and 8.6-18.6 micrograms per liter at the inlet stream site. The highest phosphorus values were found in August and are in the mesotrophic range. Similar phosphorus values were found by the FBG in August of 1983. The increase in phosphorus in August may be due to increased human activity along the inlet stream and/or around the lake during the latter part of the season.

3) Secchi disk depths were lower and chlorophyll a concentrations were higher in 1984 than in 1983. These differences may be due to year to year changes in weather. In years with high precipitation, such as 1984, more nutrients and humic acids are likely to be washed into the lake, increasing algal growth and lowering water transparency.

COMMENTS AND RECOMMENDATIONS

1) Monitoring should be continued on Chocorua Lake. If feasible, one or more trips should be made by the Freshwater Biology Group (FBG) field team in 1985 as a follow-up to the 1983 trip. This would verify and therefore strengthen lay monitor data, as well as provide a broader data base. The FBG, by providing a wider range of tests, may also be able to detect early signs of changes in lake quality that the lay monitors cannot pick up in their sampling.

2) We suggest the lay monitors collect samples for dissolved lake water color. These samples consist of the filtrate from the chlorophyll a sample. Dissolved water color, as well as chlorophyll a, influences water clarity (Secchi disk depth). By having both dissolved water color and chlorophyll a data, a more accurate assessment of water quality can be made, and with essentially no additional cost. Details on the method for collecting dissolved water color samples will be provided upon request.

3) Samples for alkalinity (buffering capacity), as well as pH, should be taken to assess the effects of acid precipitation. Alkalinity tests coupled with pH reading would provide a strong data base for Chocorua Lake, and the cost of these tests would be small. A workshop on "Testing for the Effects of Acid Precipitation" will be offered by the Freshwater Biology Group at the University of New Hampshire.

4) The program of lay monitor phosphorus sampling should be continued in 1985. Testing should be done in the spring to determine the amount of phosphorus entering the lake during the period of spring run-off, as well as during the summer. High phosphorus values in August suggest inputs from human activity, and thus areas that are likely to be sources of inputs should be sampled. Sampling should include the major inlet streams, as well as areas along the lakeshore that may be sources of substantial phosphorus loading.

METHODS OF LAY MONITORS

Lay monitors collected data on four parameters: thermal stratification, water clarity, chlorophyll *a* concentration and total phosphorus. Data were collected at weekly intervals whenever possible. Thermal profiles were obtained by collecting lakewater samples at several depths with a modified Meyer bottle (Lind, 1979). Samples were obtained by lowering the empty but weighted bottle and sampling (by pulling out the stopper) at 1-meter intervals. The temperature of the samples was measured with Taylor pocket thermometers, and recorded in degrees Celsius.

Water clarity was measured while lowering an 8-inch (20 cm) Secchi disk and holding a view-scope just below the surface to eliminate the effects of surface reflection and wave-action. When the Secchi Disk disappeared the depth mark on the plastic suspension line was noted. The disk was raised until it just came into sight, and again the depth on the line was noted. The process was repeated two to three times, and an average between the two marks on the line (the point of disappearance and the point of re-appearance) was considered to be the Secchi Disk Depth (SDD), measured to the nearest one-tenth meter (0.1 meter) -- as for example, 5.2 meters. Readings were generally taken between 9 a.m. and 3 p.m., the period of maximum light penetration.

Chlorophyll a concentration was used as an estimator of algal biomass. A weighted tube 33 feet (10 meters) in length was used to collect an integrated water sample from the 'upper-lake' (epilimnion). The weighted end of the tube was slowly lowered to the interface of the epilimnion and the 'middle-lake' (metalimnion). The end of the tube was then bent double to shut off flow of air and water, and the weighted end of the tube (presently at the base of the epilimnion) was pulled up to the surface with a plastic line attached to it. The water in the tube (epilimnetic lakewater sample) was poured into a plastic bottle by placing the weighted end of the tube into the neck of the bottle and, while keeping the bent-off end above the weighted end, unbending the upper end (allowing the sample to discharge into the bottle).

Water samples were filtered through a membrane filter with a porosity of 0.45 microns. The damp filters containing chlorophyll-bearing algae were air dried for at least 15 minutes to prevent decomposition. Filtration and drying were done in the shade to minimize destruction (by bleaching) of chlorophyll. The dried filters were then sent to UNH for analysis. [In Durham, members of the Freshwater Biology Group extracted chlorophyll in 90% acetone saturated with magnesium carbonate, and read the absorbance of the sample at standard wavelengths (663 and 750 nanometers).

Samples for total phosphorus were collected with an integrated water sampler, in the same manner as chlorophyll a, or were taken as a "dip" sample in stream areas. Water samples were stored in acid-washed 250ml polyethylene bottles, and were fixed within 1 to 2 hours with 1.0ml concentrated sulfuric acid. The samples were frozen until brought to UNH for analysis. [In Durham, the total phosphorus was digested by adding ammonium persulfate and 5N sulfuric acid and autoclaving the samples for at least 30 minutes. Finally, the phosphorus content of the sample was analyzed with the single reagent method that included a fresh solution of ascorbic acid and potassium antimony tartrate (E.P.A. 1979). Absorbance of the blue phosphorus complex was measured spectrophotometrically at 650nm].

RESULTS AND DISCUSSION

The water clarity on Chocorua Lake was moderate, averaging 4.9 meters for the entire testing period. The shallowest Secchi disk depth (3.5 meters) was found in July, the deepest (5.5 meters) in September. Chlorophyll a concentrations ranged from 0.3-1.6 milligrams per cubic meter, and averaged 1.1 milligrams per cubic meter. The lowest chlorophyll a value (0.3 milligrams per cubic meter) was found in late August, the highest (1.6 milligrams per cubic meter) in mid-July. Higher chlorophyll a concentrations were generally associated with shallow Secchi disk depths. This suggests that phytoplankton regulates the water clarity and there is little effect of dissolved water color (humic acids) on light penetration. Shallow Secchi disk depths and higher chlorophyll a concentrations in mid-July were found in 1983 and 1984. Higher chlorophyll a and shallower Secchi disk depth may reflect a pulse of algal growth at that time.

Table 1. Comparison of Secchi disk depth (SDD) and chlorophyll a (chl a) for 1984. (SDD=meters, Chl a=mg/cubicmeter).

Date	Site	SDD	Chl <u>a</u>
July 05	1 South	5.0	1.4
July 15	1 South	4.0	1.6
July 21	1 South	3.5	1.1
Aug 22	1 South	5.0	-1
Aug 30	1 South	5.3	0.3
Sept 16	1 South	5.5	1.0
Oct 07	1 South	5.0	1.0

Compared to 1983, Secchi disk depths were shallower and chlorophyll a concentrations were higher this year, during overlapping time periods. Secchi disk depths were generally 0.5-1.0 meters shallower in 1984. These differences may be due to year to year changes in weather. During years with high precipitation, such as 1984, more nutrients and humic acids are likely to enter the lake. Higher nutrient availability may increase algal growth, while increased concentrations of humic acids in the water lowers water transparency by staining the water. Also, as algal growth increases, Secchi disk depth decreases.

Total phosphorus is usually the most limiting (least abundant) nutrient to algae in freshwater systems. Phosphorus regulates algal productivity and therefore regulates chlorophyll a concentration and indirectly (through chlorophyll a concentration) influences water transparency. Thus, increases in algal growth may occur with increases of phosphorus loading. Total phosphorus concentrations from site 1 ranged from 2.5-17.2 micrograms per liter (Table 2). Phosphorus samples from the inlet site ranged from 6.1-18.2 micrograms per liter (Table 2). The highest values from both sites are in the mesotrophic range. These high values were found in August, and are similar to values found by the FBG in August of 1983. These values indicate higher inputs of phosphorus during the latter part of the season. This may be due to increased activity around the lake or along the inlet in the late summer.

Table 2. Total phosphorus (TP) data from Chocorua Lake for 1984.
(TP=micrograms/liter)

Date	Site	TP
July 05	1 South	6.1
July 16	1 South	2.5
Aug 22	1 South	17.2
July 05	Inlet	8.6
Aug 23	Inlet	18.6

The shallowest Secchi disk depths and the highest total phosphorus concentrations are in the mesotrophic range. Based on average Secchi disk depth and total phosphorus concentration, Chocorua Lake would be classed as meso-oligotrophic. Chlorophyll a values were well within the oligotrophic range. High phosphorus values, such as those found in August, are usually associated with higher chlorophyll a values. However, from the phosphorus data collected, it appears that the high phosphorus concentrations are not found throughout the entire season; rather, they are found in the late summer. The rapid flushing rate at Lake Chocorua may help to maintain low concentration of phosphorus throughout most of the season.

Seasonal averages are useful, but are limited in their interpretive value. On a seasonal basis chlorophyll a concentrations were low, however higher concentrations in mid-July may reflect a pulse of algal growth at that time. The presence of an increase in algal growth during the summer may indicate a change in water quality at Lake Chocorua, and should be watched carefully in the future.

REFERENCES

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- U.S. Environmental Protection Agency. 1979. A manual of methods for chemical analysis of water and wastes. Office of Technology Transfer, Cincinnati. PA-600/4-79-020.